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DRIED MILK POWDER IN INFANT FEEDING.

SAFETY, USEFULNESS, AND COMPARATIVE VALUE—A PRELIMINARY REPORT.

By W. H. PRICE, Surgeon (R), United States Public Health Service.

Introduction.

The appearance of dry milk powder as a common household commodity in the retail shops, and in possession of some city milk dealers, suggests inquiry regarding the safety and usefulness of remade milk from the human nutritive point of view. Normal growth and the development of children depend in large measure on the presence of milk in their diet. Fresh cows' milk is believed to be the best available substitute for mothers' milk. The convenience, in some respects, of whole milk powder invites some mothers to substitute it for natural milk. During periods of shortage certain milk dealers increase their stock by adding remade to natural milk. What influence these substitutions will have on the growth and vitality of children is a matter of considerable public-health importance. The United States Public Health Service, the Boston Baby Hygiene Association, the Boston Health Department, and several other agencies are cooperating to determine something of the nature of that influence.

The fat, sugar, protein, and salts contained in the various brands of dry milk powder can be easily determined in any laboratory equipped to make similar tests of natural milk. Determination of digestibility and the presence of vitamines is a different matter, and these are indispensable requisites in the diet of infants. Regarding the food value of dry milk powder, as indicated by its effect on animals, I am permitted to quote Prof. E. V. McCollum as follows:

"So far as I have been able to determine by experiments on animals, the milk powders which I have employed have essentially the same dietary properties as fresh milk. I hold the view that one can not draw conclusions from experiments on animals as to the value of milk products in infant feeding. The span of life of the rat is rarely longer than 36 months, and any animals with which we deal in the laboratory in our experiments correspond to children of 8 to 10 years or older. We can not possibly experiment with a rat before it is 35 or 40 days old. Furthermore, the bacteriological factor is an important one in nutrition, and it is not safe to conclude that different species will react in quite the same way. The third factor of great

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importance in this connection is the now well-established principle that the human species requires an antiscorbutic substance, whereas the rat, so far as we can determine, and we have studied it very thoroughly, can not be made to develop scurvy, and apparently does not need this substance in its food supply."

The following brief review of the literature relating to certain phases of the dietary properties of dry milk powder is furnished by Milton V. Veldee, Acting Assistant Surgeon, United States Public Health Service:

"Infant feeding involves more than the simple introduction of measured amounts of carbohydrate, fat, and protein into the baby's alimentary tract. Mother's milk has been provided with certain accessory factors, generally termed 'vitamines,' which are absolutely essential to proper growth and development. When it becomes necessary to resort to artificial feeding the normal vitamine balance is thrown out. This phase of artificial feeding has been extensively investigated with regard to cow's milk, also with pasteurized milk, and must now be considered from a new angle.

"With the introduction of dried milk powder into the field of complete foods for infant feeding, the question of antiscorbutic and antineuritic vitamines is again revived. The value of whole fresh milk as an antiscorbutic is now well recognized as being very low. Pasteurization further decreases the antiscorbutic value. Hess (1)[1] concluded that 'the antiscorbutic value of pasteurized milk is inversely proportional to the time elapsed between pasteurization and consumption.' The time element applies also to raw milk, but to a much greater degree to dried milk powder. The same author concluded that babies fed on pasteurized milk should receive an antiscorbutic from the time they are a few weeks old, as there is no reason for allowing the negative balance of 'vitamine' to continue for a longer period.' Hess and Unger (2)[1] contend that the antiscorbutic value of dried milk depends largely upon the method of manufacture. They are not in agreement with Chick and Hume who, working at the Lyster Institute, found that dried milk is devoid of all antiscorbutic value. To substantiate their contention they selected a brand which, in the process of making, is heated to 116° C., for only a few seconds. Such a powder fed in 10 gram quantities (equivalent to 80 cc. of whole milk) caused guinea pigs who had previously developed scurvy to become well and gain weight. In another experiment (3)[1] they were able to cause distinct improvement in two babies, who had developed scurvy on a malt soup diet, by substituting a diet of dried milk. Chick, Hume, and Skelton (4)[1] present data, as the result of guinea pig experimentation, and conclude that raw milk contains the accessory food factor which protects from scurvy, but that this is present in small amounts and that it is further decreased by heating or drying. From this they conclude, as did Hess, that artificially fed babies should receive some additional antiscorbutic ration. In another article (5)[1] they find that dried milk is largely, if not entirely, lacking in antiscorbutic vitamine. This loss they think occurs either during the process of drying or during the storage period which necessarily follows before consumption. Hart,

[1] Figure indicates reference at end of article.

Steenbock, and Smith (6)[1] working with Merrell-Soule powder found that guinea pigs could not eat enough of this powder in addition to hay and rolled oats to prevent scurvy. Barnes and Hume (7)[1] ran parallel series of guinea pigs and monkeys on fresh raw milk and fresh dried milk. The results were the same in both sets of animals. Dried milk powder could not protect the animals from contracting scurvy, even in quantities much greater than that required of fresh raw milk.

"This variation in the antiscorbutic value of dried milk powders, as found by the various investigators, is apparently dependent on two factors: (1) The freshness of the milk before drying and the method of drying; (2) the element of time between drying and consumption. We therefore must conclude from the evidence at hand that, as the result of drying and storing, milk loses some, if not all, of its already poor antiscorbutic property; and, further, that babies fed on this food should receive from the beginning additional antiscorbutic substance, preferably orange juice.

"From the work thus far reported it would seem that the antineuritic vitamines, fat soluble A and water soluble B, are comparatively thermostable. E. V. McCollum (8) (9) (10) [1] and his associates have conducted a great deal of such research on rats. They find that dried milk has lost none of its antineuritic vitamine. But they found that heating dried milk powder in a double boiler for four hours did cause a considerable decrease in its antineuritic value. Osborne and Mendel (11) [1] summarize their work on rats by saying: 'Indeed we have no reason to believe that the nutrition-promoting properties of milk are lost by brief periods of heating. Comparative trials made with approximately equivalent amounts of protein-free milk (a mixture of dried milk, starch, and lard) and fresh milk not incorporated with the food mixture, have shown substantially the same results.' Hopkins and Neville (12) [1] at an earlier date found similar results. It has been shown by several workers that the vitamine content of milk from various animals varies directly with the vitamine content of the food eaten. Consequently cow's milk will show variations from season to season. Gibson and Concepcion (13) [1] found no antineuritic deterioration in cow's milk through autoclaving for two hours at 125° C. They were working with fowl, dogs, and pigs. They believe that young are born with an excess supply of antineuritic vitamines, and that it is this surplus that carries the baby over until foods other than milk are given.

"Data pertaining to the nutrition-promoting property of dried milk on infants are still lacking. Accurate conclusions can not be drawn from rat, dog, fowl, or pig experimentation because of the differences in the duration of the nursing life of these animals as compared with babies."

The Present Study.

Difficulties beset attempts to demonstrate usefulness and comparative value of different foods with human subjects, and these difficulties are multiplied when infants are involved. Individual tolerance for different foods varies among infants; and their home surroundings, including economic status, medical and nursing super-

[1] Figure indicates reference at end of article.

vision, and the intelligence of their mothers, are also variable factors. To offset these variations the average of a large number of infants must be secured. To eliminate the influence of other foods in their diet, babies less than six months old and who are entirely artificially fed are required. To observe the development, if any, of scurvy, rickets, malnutrition, and predisposition to other diseases, tests extending over several years are desirable. In the case of remade milk, the quality of natural milk used in manufacture, the different processes of drying and remaking, and the length of time of storage before remaking, result in varying qualities in the remade product. To determine the safety and usefulness of all varieties of dry milk powder now on the market would require an exceedingly large number of infants.

The Boston Baby Hygiene Association encourages maternal nursing with such success that, although 6,000 infants less than 1 year old were under its supervision when this study was undertaken, only 196 babies were found to be less than 6 months old and entirely artificially fed. For various reasons, including infrequent attendance of babies at conference, feeble-minded mothers, noncooperative mothers, and refusal by mothers to permit their babies to participate in the study, the number of babies available for the study was further reduced at its beginning. Division of the small number finally available among several brands of dry milk powder would probably have so reduced the numbers included in each group as to preclude collection of valuable data regarding any brand; therefore, only one brand was used in this study, but both whole milk powder and skimmed milk powder were employed. The study has continued only three months, hence only general conclusions can be drawn. The desire to contribute such first-hand information as is available to the members of the International Association of Dairy and Milk Inspectors for their consideration when attempting regulation of the manufacture and sale of dry milk powder and remade milk actuates the reporting of these meager data at this time.

The following is abstracted from a statement by its manufacturers regarding the dry milk powder that was used in this study:

"Natural milk used in the manufacture of this dry milk powder conforms to the requirements for Grade B milk, New York City inspection. Last night's and this morning's milk is received at the factories and processed this morning. It is therefore much fresher than would be the same Grade B milk if delivered as natural milk in New York City. Its acidity is low and no neutralization is needed or practiced. Whole milk powder is prepared from natural milk which contains 3.5 per cent butter fat. Natural milk, whether whole or skimmed, is first pasteurized by the holding process, 145° for 30 minutes, then condensed by the vacuum-pan process, the whole milk to a ratio of about 3½ to 1; the skimmed milk to about 4¼ to 1; then dried by the spray process, whereby the condensed milk is

injected in a fine spray into a chamber having a hot air blast of about 240° F.

"The process of evaporation not only reduces the temperature of the air current to 170° or 180° F., but by the rapidity and intensity of its action keeps the individual particles of milk in a cool condition until they are dried; and this assertion is borne out by the fact that the lact-albumen is not coagulated and the enzymes are not destroyed."

The milk powder employed in this study was received direct from the factory at monthly intervals and was therefore comparatively fresh when used. The chemical and bacteriological laboratories of the Boston Health Department made numerous examinations of these dry milk powders and their remade products both before the study began and during its progress. These examinations disclosed the following:

One hundred and sixty-four grams (1½ cupfuls of an ordinary 8-ounce tin measuring cup) of the whole milk powder combined with 1 quart of water produces a reconstituted milk which contains the following constituents: Fat, 4 per cent; sugar, 5.7 per cent; protein, 3.7 per cent. Four per cent fat was desired, and these proportions were employed with one group in the study.

Made in the above proportions, with tap water and clean but not sterilized utensils, this mixture contains between 2,000 and 12,000 bacteria per cc.

Unsalted butter and skimmed milk powder were emulsed by means of a well-known centrifugal apparatus and the resulting product was fed to another group of infants. This reconstructed milk contained the following constituents: Fat, 4 per cent; sugar, 5.1 per cent; protein, 3.1 per cent.

The bacterial count of this product ranged between 35,000 and 45,000 bacteria per cc.

The Boston Baby Hygiene Association gives special attention to the quality of the milk that is fed to babies under its supervision. Nearly all are fed what is known locally as "Grade A" milk. This is an unofficial grade, but special precautions are taken during its production, handling, and distribution. It is pasteurized by the holding process, 145° F. for 30 minutes, at the plant of a large city milk dealer. This milk contains the following constituents: Fat, 4 per cent; sugar, 4.8 per cent; protein, 3.18 per cent. The bacterial count of this milk ranges between 6,000 and 90,000, averaging 32,000 per c. c. Orange juice is usually advised in connection with this diet, but, on account of varying home conditions, little uniformity prevails regarding its introduction.

The following instructions were issued to the nurses of the Boston Baby Hygiene Association at the beginning of the study:

Regarding the Feeding Study.

To ascertain the human nutritive value of powdered milk is of considerable practical importance. Powdered milk is increasing as an article of commerce, it may become a common household commodity, and certain economic phases are connected

with it. There are indications that in nutritive value and digestibility, powdered milk compares favorably with natural milk, but that point has not been proved scientifically by feeding powdered milk and natural milk to different groups of individuals who are under observation of the same clinicians and comparing the results.

The United States Public Health Service, the Boston Baby Hygiene Association, the Boston Health Department, and several other agencies are cooperating to ascertain the value of powdered milk from the human nutritive point of view. The data resulting from this cooperation will assist Federal, State, and city food officials in framing and enforcing health regulations regarding manufacture and sale of powdered milk. The information obtained will also assist in controlling morbidity in infants.

Only infants less than six months old and who are entirely artificially fed will be included in the study. Babies on diet will not be included. Orange juice may be given, however, as it is given to babies on Grade A milk. The babies in the study will be divided into three groups, the divisions being made according to the kind of food used.

Group 1 will consist of babies whose modifications are prepared from Grade A milk The constituents of this natural milk are: Fat, 4 per cent; sugar, 4.8 per cent; protein, 3.18 per cent.

Group 2 will consist of babies whose modifications are prepared from whole milk powder which will be reconstituted in the homes. This powder will be kept on hand in the stations and dispensed by the nurses. The powder comes in 5-pound tins, and the nurse should know how long a tin should last. The paper wrapper must be removed and a label marked "Baby Milk Powder" pasted on the tin.

Group 3 will consist of babies whose modifications are prepared from milk which has been reconstructed from unsalted butter and skimmed-milk powder. This preparation will be delivered as is Grade A milk.

The conference physician will order all modifications, as usual.

METHOD OF PREPARING MILK.

For Group 1: Same as usual.

For Group 2: Add 164 grams (equivalent to 1½ cupfuls) of the whole milk powder to 1 quart of cooled boiled water. When measuring the powder, dip it from the tin with a large spoon. The powder is light and should not be packed down. Beat with a Dover egg beater until it is thoroughly mixed. The constituents of this mixture will be approximately as follows: Fat, 4 per cent; sugar, 5.7 per cent; protein, 3.71 per cent. The per cent of sugar will be about 1 higher than in Grade A milk. The conference physician, when ordering modifications that use this mixture as a basis, will take this fact into consideration when ordering the sugar.

For Group 3: The constituents of this reconstructed milk will be approximately as follows: Fat, 4 per cent; sugar, 5.1 per cent; protein, 3.1 per cent. The method of modification will be the same as if Grade A were used.

THE FOLLOWING DATA SHOULD BE RECORDED ON HISTORY CARDS:

(1) Weight of baby at beginning and at least every two weeks thereafter.

(2) Strength and amount of feeding, hours of feeding, amount taken in 24 hours, and changes made. (The conference physician may change the food, either to a different modification of the same food or to a different food, but the reason for such change should be recorded. It is hoped that a fair trial will be given each food before changes are made, but the welfare of the children comes first and changes should be made in their interest.)

(3) Nature and extent of any illness, and treatment.

(4) General condition of the baby with special reference to character and changes in stools, general development, activity, teething, and disposition.

(5) Environment of the baby, with special reference to the mother's intelligence and cooperation.

The babies included in this study should be watched closely, and careful notes must be made after each visit.

This is an unusual opportunity for the baby hygiene association to contribute to the cause of baby welfare and of public health. The success of the study depends largely on the excellent work which the staff nurses can do. Accurate observations and recording are essential to success.

The results of the study will be compiled at the central office at the end of 3 months and in due time be made available to officials charged with regulation of milk supplies and to the medical profession.

Progress of the study.

The nurses at the various conference stations submitted the names of all artificially fed babies who were less than 6 months old to the central office of the association. The director of the association assigned the babies to the various groups, thus eliminating any partiality in the selections. Some delay occurred in beginning the study, with the result that a few of the babies were slightly more than 6 months old when the feeding was actually begun.

Babies were first fed remade milk on August 18, and the study was extended as rapidly as the nurses could visit the homes and demonstrate the preparation of the new foods. Other babies than those assigned at the beginning have been added to the groups, but the tabulations presented here include none of those who were added subsequent to September 24.

It was thought desirable at the beginning, but after the groups were formed, to classify all babies in subgroups such as "Well," "Slightly sick," "Sick," and "Very sick," according to their physical condition, and a fairly definite system for so doing was improvised. In the cases of individual babies some very interesting data developed from this subgrouping, but the numbers included in these subdivisions are so small that it is impractical to draw conclusions from them as subgroups. The subdivisions remain, but are not utilized in this report.

Some difficulty was experienced in obtaining a perfect emulsion of the unsalted butter and powdered skimmed milk. A thin float of fat appeared on the surface of the milk in the necks of the bottles and this difficulty was never entirely overcome. This loss of fat was compensated for, however, so that the remaining emulsion contained the required 4 per cent, and the float was removed and discarded. It is believed that the ingredients and the machine used in this study are capable of producing better results than we obtained, but it is doubtful if better results are likely to be obtained in commercial practice at the present time.

This study was conducted under such practical conditions as are likely to prevail if remade milk should be used for infant feeding in the home; it did not, therefore, afford opportunity for as close

observations and control as would have been possible with hospitalized babies.

A considerable number of mothers refused the invitation to transfer their babies from natural milk to either form of remade milk. The psychology which prompted this refusal prevailed to some, though to a less, extent among the mothers who accepted the invitation. Without material reason for so doing, a number of mothers removed their babies from the remade milk within a few days after beginning its use. The appearance of the floating fat previously referred to was also a disturbing influence to some. A number of the mothers consulted private physicians who, on general principles, advised discontinuance of the remade milk. This was to be expected because the use of remade milk in infant feeding is comparatively new and not universally understood.

Such data as were obtained are contained in the following tables. The columns "Change made by" and "Approval of conference physician or nurse" are taken to be the significant ones of these tables. It is permissible to assume that the conference physicians and nurses would have removed the babies from the remade milk groups on the development of any untoward symptoms that might reasonably be attributed to the remade milk; and yet removal of babies by the conference physicians does not necessarily justify condemnation of remade milk for infant feeding, for the conference physicians took no chances but removed babies on the development of symptoms or for lack of progress which was only remotely attributable to the remade milk. Mothers and private physicians, on the other hand, actuated by the psychology previously referred to (i. e., prejudice against any new form of infant feeding), are likely to remove babies from studies of this kind without any material reason for so doing.

No attempt was made to transfer babies from Group 1 (natural milk) to either of the other groups; therefore, no table "Taken off" is presented for Group 1. In the weight table for Group 1, however, it will be noticed that 9 babies did not return to the conference stations to be weighed during the second period of the study. It is reasonable to conclude that had these babies been on a new and not universally understood diet a considerable proportion of them would have been removed from it.

GROUP 1.—*Natural milk.*

Number.	At beginning.				First period.						Second period.						Entire period.						Remarks.
	Age.		Weight.		Time on.		Gain.		Loss.		Time on.		Gain.		Loss.		Time.		Gain.		Loss.		
	Mos.	Days.	Lbs.	Oz.	Mos.	Days.	Lbs.	Oz.	Lbs.	Oz.	Mos.	Days.	Lbs.	Oz.	Lbs.	Oz.	Mos.	Days.	Lbs.	Oz.	Lbs.	Oz.	
Well.																							
A-1	4	21	11	6	0	7	0	3	0	0	2	23	3	4	0	0	3	0	3	7	0	0	
A-2	4	7	12	12	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	9	0	0	
A-3	3	26	13	3	2	3	3	7	0	0	0	27	0	2	0	0	3	0	3	9	0	0	
A-4	3	25	11	13	1	25	3	5	0	0	0	27	1	7	0	0	2	22	4	12	0	0	
A-5	3	9	11	6	1	18	2	14	0	0	1	4	1	5	0	0	2	22	4	3	0	0	
A-6	3	14	11	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
A-7	5	2	11	13	2	16	2	5	0	0	0	0	0	0	0	0	2	16	2	5	0	0	
A-8	3	16	10	6	1	29	2	8	0	0	0	0	0	0	0	0	1	29	2	8	0	6	
A-9	3	13	13	8	1	5	1	7	0	0	0	0	0	0	0	0	1	5	1	7	0	0	
A-10	3	25	13	2	1	4	1	6	0	0	0	0	0	0	0	0	1	4	1	6	0	0	
A-11	4	6	14	10	1	25	2	10	0	0	0	0	0	0	0	0	1	25	2	10	0	0	
A-12	3	27	12	8	1	5	1	3	0	0	1	3	1	14	0	0	2	8	3	1	0	0	
A-13	4	2	11	11	2	5	1	13	0	0	0	20	0	11	0	0	2	25	2	8	0	0	
A-14	5	0	12	13	0	20	0	0	1	0	0	0	0	0	0	0	0	20	0	0	1	0	Now in hospital.
A-15	5	0	12	15	2	2	2	13	0	0	0	0	0	0	0	0	2	2	2	13	0	0	
A-16	3	26	11	5	1	11	2	3	0	0	1	11	0	10	0	0	2	22	2	13	0	0	
A-17	4	29	10	0	2	5	2	9	0	0	0	27	0	3	0	0	3	2	2	12	0	0	
Slightly sick.																							
A-18	2	6	8	10	1	26	2	10	0	0	1	4	1	15	0	0	3	0	4	9	0	0	
A-19	1	26	8	6	2	12	4	7	0	0	0	20	1	5	0	0	3	2	5	12	0	0	
A-25	1	0	10	1	1	4	1	15	0	0	2	2	2	14	0	0	3	6	4	13	0	0	
Sick.																							
A-20	3	0	5	12	2	2	0	12	0	0	0	20	0	10	0	0	2	22	1	6	0	0	
A-21	3	17	10	0	1	19	2	2	0	0	1	4	0	12	0	0	2	23	2	14	0	0	
A-22	5	1	11	1	2	0	1	11	0	0	0	22	0	5	0	0	2	22	2	0	0	6	
A-23	1	7	6	6	0	28	1	5	0	0	0	0	0	0	0	0	0	28	1	5	0	0	
A-24	1	7	6	0	0	28	1	1	0	0	(1)	0	0	0	0	0	0	28	1	1	0	0	"Indigestion."
A-26	5	16	10	15	1	19	1	1	0	0	0	27	2	5	0	0	2	16	3	6	0	0	
Very sick.																							
A-27	3	0	7	15	0	10	0	0	0	2	0	0	0	0	0	0	0	10	0	0	0	2	
A-28	5	6	13	4	1	4	1	4	0	0	0	0	0	0	0	0	1	4	1	4	0	0	
Total (28 babies)[2]	103	4	304	13	40	2	47	12	.....	.....	17	1	19	10	.....	.....	60	3	70	15	.....	.....	
Average	3	20.5	10	14.2	Average per capita gain per day of 26 babies=0.635 oz.						Average per capita gain per day of 15 babies=0.614 oz.						Average per capita gain per day of 27 babies=0.629 oz.						

[1] Died at Infants' Hospital.

[2] Figures in "gain" columns represent net gain.

GROUP 2.—*Stayed on whole milk powder.*

Number.	At beginning.				First period.				Second period.						Entire period.					
	Age.		Weight.		Time on.		Gain.		Time on.		Gain.		Loss.		Time on.		Gain.		Loss.	
	Mos.	Days.	Lbs.	Oz.	Mos.	Days.	Lbs.	Oz.	Mos.	Days.	Lbs.	Oz.	Lbs.	Oz.	Mos.	Days.	Lbs.	Oz.	Lbs.	Oz.
Well.																				
B-1	6	10	13	14	2	4	4	7	0	21	1	6	0	0	2	25	5	13	0	0
B-2	1	27	8	8	2	2	5	0	0	22	0	12	0	0	2	24	5	12	0	0
B-3	4	1	14	11	1	28	3	6	0	28	1	3	0	0	2	26	4	9	0	0
B-4	3	20	12	1	2	4	3	5	0	21	0	7	0	0	2	25	3	12	0	0
B-5	5	10	12	12	1	4	1	7	1	18	2	2	0	0	2	22	3	9	0	0
B-6	4	4	11	4	1	4	2	10	1	18	2	9	0	0	2	22	5	3	0	0
B-7	4	21	15	5	1	12	1	4	0	21	0	6	0	0	2	3	1	10	0	0
B-8	2	22	8	14	2	2	3	10	0	21	1	1	0	0	2	23	4	11	0	0
B-9	4	27	12	0	1	3	2	6	1	4	1	5	0	0	2	7	3	11	0	0
B-10	3	6	11	14	1	18	2	9	1	4	2	4	0	0	2	22	4	13	0	0
B-11	5	3	14	14	1	19	2	4	0	21	1	9	0	0	2	10	3	13	0	0
B-12	4	17	12	10	1	11	2	12	0	29	0	10	0	0	2	10	3	6	0	0
Slightly sick.																				
B-13	4	6	10	8	0	20	1	7	1	4	2	6	0	0	1	24	3	13	0	0
B-14	0	28	8	2	1	14	1	5	1	3	1	9	0	0	2	17	2	14	0	0
B-15	3	11	12	4	1	14	2	12	0	18	1	4	0	0	2	2	4	0	0	0
B-16	2	29	10	0	1	11	1	5	0	0	0	0	0	0	1	11	1	5	0	0
B-17	4	27	10	0	1	11	2	7	0	26	1	8	0	0	2	7	3	15	0	0
B-18	3	7	11	1	1	1	2	11	1	0	1	15	0	0	2	1	4	10	0	0
B-19	5	13	13	9	1	11	2	9	0	26	1	4	0	0	2	7	3	13	0	0
B-20	5	14	11	1	1	15	4	2	0	24	0	11	0	0	2	9	4	13	0	0
B-21	2	15	5	15	2	4	3	8	0	20	1	2	0	0	2	24	4	10	0	0
Sick.																				
B-22	3	16	6	7	2	2	4	5	0	13	1	3	0	0	2	15	5	8	0	0
B-23	4	20	8	8	2	2	3	8	0	20	1	2	0	0	2	22	4	10	0	0
B-25	1	28	6	1	1	12	1	2	0	28	1	0	0	0	2	10	2	2	0	0
B-26	3	0	7	13	0	19	0	9	1	0	0	15	0	0	1	19	1	8	0	0
B-27	4	1	9	0	0	20	1	1	0	21	1	9	0	0	1	11	2	10	0	0
B-28	3	5	8	14	1	5	0	12	1	1	1	6	0	0	2	6	2	2	0	0
Very sick.																				
B-29	3	3	7	13	1	26	2	3	0	27	1	0	0	0	2	23	3	3	0	0
B-30	1	0	7	0	2	0	7	2	0	13	0	0	0	3	2	13	6	15	0	0
B-31	2	1	10	1	1	13	1	15	1	1	5	7	0	0	2	14	7	6	0	0
Total (30 babies)[1]	110	2	312	12	45	11	79	11	25	23	40	12	.....	.....	71	4	120	7	.....	.....
Average	3	20	10	6.8	Average per capita gain per day of 30 babies, =0.937 ounce.				Average per capita gain per day of 29 babies=0.844 ounce.						Average per capita gain per day of 30 babies=0.903 ounce.					

[1] Figures in "gain" columns represent net gain.

GROUP 2.—*Taken off whole milk powder. Data while on.*

Number.	At beginning.				First period.					
	Age.		Weight.		Time on.		Gain.		Loss.	
	Months.	Days.	Pounds.	Ounces.	Months.	Days.	Pounds.	Ounces.	Pounds.	Ounces.
Well.										
B-32	5	6	14	14	0	21	0	0	0	0
B-33	5	2	13	2	0	3	0	5	0	0
Slightly sick.										
B-34	2	21	8	1	1	4	1	0	0	0
B-35	5	26	15	0	0	20	1	0	0	0
Very sick.										
B-36	1	5	7	8	0	9	0	0	0	0
B-37	2	15	12	2	0	21	1	0	0	0
Total (6 babies) [1]	22	15	70	11	3	18	2	14	.....	.....
Average	3	22.5	11	12.5	Average net gain per capita per day of 6 babies=0.426 ounce.					

[1] Figures in "gain" columns represent net gain,.

GROUP 3.—*Stayed on emulsed milk (unsalted butter and skimmed milk powder).*

Number.	At beginning.				First period.						Second period.						Entire period.					
	Age.		Weight.		Time on.		Gain.		Loss.		Time on.		Gain.		Loss.		Time on.		Gain.		Loss.	
	Mos.	Days.	Lbs.	Oz.	Mos.	Days.	Lbs.	Oz.	Lbs.	Oz.	Mos.	Days.	Lbs.	Oz.	Lbs.	Oz.	Mos.	Days.	Lbs.	Oz.	Lbs.	Oz.
Well.																						
C-1	5	22	13	11	1	27	3	11	0	0	0	21	1	4	0	0	2	18	4	15	0	0
C-2	3	5	10	4	1	23	1	11	0	0	0	21	1	11	0	0	2	14	3	6	0	0
C-3	3	4	11	8	1	26	3	0	0	0	0	14	0	3	0	0	2	10	3	3	0	0
C-4	2	18	12	11	1	23	2	9	0	0	0	28	1	13	0	0	2	21	4	6	0	0
C-5	5	1	14	2	1	10	3	2	0	0	1	8	3	5	0	0	2	18	6	7	0	0
C-6	4	3	14	8	1	13	2	0	0	0	0	14	1	4	0	0	1	27	3	4	0	0
C-7	4	25	16	12	0	11	0	7	0	0	0	0	0	0	0	0	0	11	0	7	0	
Slightly sick.																						
C-8	3	26	12	7	1	25	2	4	0	0	0	21	1	1	0	0	2	16	3	5	0	0
C-9	4	10	12	3	1	14	1	10	0	0	1	4	1	6	0	0	2	18	3	0	0	0
Sick.																						
C-10	3	18	8	14	1	27	2	0	0	0	0	21	0	13	0	0	2	18	2	13	0	0
C-11	6	3	15	7	1	12	1	1	0	0	1	3	0	15	0	0	2	15	2	0	0	0
C-12	1	15	9	6	1	23	3	2	0	0	0	28	2	3	0	0	2	21	5	5	0	0
Very sick.																						
C-13	3	12	10	14	1	3	1	11	0	0	0	26	0	10	0	0	1	29	2	5	0	0
C-14	4	16	9	0	1	28	4	6	0	0	0	14	0	9	0	0	2	11	4	15	0	0
Total (14 babies)	55	28	171	11	21	24	32	10	.....	.....	10	13	17	1	0	0	32	7	49	11	.....	.....
Average	4	0	12	4.2	Average per capita gain per day of 14 babies=0.798 ounce.						Average per capita gain per day of 13 babies=0.872 ounce.						Average per capita gain per day of 14 babies=0.822 ounce.					

GROUP 2.—*Taken off whole milk powder.*

Number.	At beginning.					On powder.		Weight.		Condition.	Change made by—	Approval of conference physician or nurse?	Remarks.
	Age.		Weighed.		Condition.								
	Mos.	Days.	Lbs.	Oz.		Mos.	Days.	Lbs.	Oz.				
B-36	1	5	7	8	Very sick	0	9	7	5	Better	Private physician	No.	
B-38	4	13	9	14	Slightly sick	0	1	[1]	0	No change	Mother	No.	
B-39	1	21	7	9	do	0	2				do	No.	
B-40[2]						[3]	0	[1]	0	No change			
B-32	5	6	14	14	Well	0	21	14	10	do	Nurse	Yes.	Nurse did not believe baby was getting powder.
B-41	5	15	[1]	[1]		0	9	[1]	0	do	Mother	No.	
B-42	2	19	9	2	Well	0	26	[1]	0	do	do	No.	Back on powder again.
B-43	3	26	13	8	do	[3]	0	[1]	0	do	do	No.	
B-44	2		12	4	do	[3]	0	[1]	0	do	do	No.	
B-45	1	4	9	8	Well. (On sugar; reported on full milk formula.)	0	5	[1]	0	Sick (overfeeding)	Private physician		Error due to mother's misstatement,
B-46	4	15	10	1	Sick	0	5	[1]	0	No change	do	No.	Related to B-45, same physician.
B-47	4	15	14	2	Well	0	5	[1]	0	do	do	No.	Friend of B-45, same physician.
B-34	2	21	8	1	Slightly sick	1	4	9	1	do	Mother	No.	
B-48	1		8	6	Sick	[3]	[3]	[1]	0	do	Private physician	No.	
B-35	5	26	15		Slightly sick	0	20	16	0	do	Conference physician	Yes.	To a fat-free formula.
B-37	2	15	12	2	Very sick	0	21	13	2	Better	Mother	No.	
B-49	2	11	12	10	Seemed well	[3]	[3]	[1]	0	No change	do	No.	
B-50	2	20	10	10	Well	0	1	[1]	0	do	do	No.	
B-33	5	2	13	2	do	0	3	13	7	do	Private physician	No.	

[1] Not weighed.

[2] Died following operation for congenital defect.

[3] Few days.

GROUP 3.—*Taken off emulsed milk (unsalted butter and skimmed milk powder).*

Number.	At beginning.					On emulsed.		Weight.		Condition.	Change made by—	Approval of conference physician or nurse?	Remarks.
	Age.		Weighed.		Condition.								
	Mos.	Days.	Lbs.	Oz.		Mos.	Days.	Lbs.	Oz.				
C–19	6	21	16	4	Sick	0	15	16	9	Locse movements	Mother	No	
C–24	5	25	13	9	Slightly sick	(1)	0	(2)	0	No change	do	No	
C–20	2	10	11	1	Very sick	0	3	10	10	do	Conference physician	Yes	
C–15	2	20	12	2	Well	1	15	13	3	Not so well	do	Yes	
C–17	5	9	12	0	Sick	1	15	13	2	do	do	Yes	
C–16	1	14	7	10	Slightly sick	0	19	8	6	No change	Mother	No	
C–18	6	3	11	14	Sick	2	0	13	5	Not doing well	Conference physician	Yes	
C–21	2	0	7	2	Very sick	0	13	7	5	Better	do	Yes	
C–25	1	21	8	10	Slightly sick	1	0	9	6	No change	do	Yes	
C–26	3	25	12	12	Well	0	0	0	0		Family moved		Baby lost track of.
C–27	1	15	7	10		0	0	8	8		do		Do.
C–22	2	17	10	12	Very sick	0	14	10	8	No change	Mother	No	
C–23	6	2	10	8	do	1	21	11	8	do	Conference physician	Yes	
C–28						0	2				Mother	No	

[1] Few days.

[2] Not weighed.

GROUP 3.—*Taken off reconstructed milk (sweet butter and powdered skimmed).—Data while on.*

Number.	At beginning.				First period.					
	Age.		Weight.		Time on.		Gain.		Loss.	
	Months.	Days.	Pounds.	Ounces.	Months.	Days.	Pounds.	Ounces.	Pounds.	Ounces.
Well.										
C-15	2	20	12	2	1	15	1	1	0	0
Slightly sick.										
C-16	1	14	7	10	0	19	0	12	0	0
Sick.										
C-17	5	9	12	0	1	15	1	2	0	0
C-18	6	3	11	14	2	0	1	7	0	0
C-19	6	21	16	4	0	15	0	5	0	0
Very sick.										
C-20	2	10	11	1	0	3	0	0	0	7
C-21	2	0	7	2	0	13	0	3	0	0
C-22	2	17	10	12	0	14	0	0	0	4
C-23	6	2	10	8	1	21	1	0	0	0
Total (9 babies)[1]	35	6	99	5	8	25	5	3	.....	.....
Average	3	27	11	5	Average net gain per capita per day of 9 babies, 0.313 ounce.					

[1] Figures in "gain" column represent net gain.

Summary.

	Group 1.	Group 2.			Group 3.		
		Stayed on.	Taken off.	Total.	Stayed on.	Taken off.	Total.
At beginning:	*28 babies.*	*30 babies.*	*6 babies.*	*36 babies.*	*14 babies.*	*9 babies.*	*23 babies.*
Total age	103 mos. 4 days	110 mos. 2 days	22 mos. 15 days	132 mos. 17 days	55 mos. 28 days	35 mos. 6 days	91 mos. 4 days.
Average age	3 mos. 20.5 days	3 mos. 20 days	3 mos. 22.5 days	3 mos. 20.5 days	4 mos	3 mos. 27 days	3 mos. 29 days.
Total weight	304 lbs. 13 oz	312 lbs. 12 oz	70 lbs. 11 oz	383 lbs. 7 oz	171 lbs. 11 oz	99 lbs. 5 oz	271 lbs.
Average weight	10 lbs. 14.2 oz	10 lbs. 6.8 oz	11 lbs. 12.5 oz	10 lbs. 10.5 oz	12 lbs. 4.2 oz	11 lbs. 0. 5 oz	11 lbs. 12 oz.
First period:	*26 babies.*	*30 babies.*	*6 babies.*	*36 babies.*	*14 babies.*	*9 babies.*	*23 babies.*
Time o feeding	40 mos. 2 days	45 mos. 11 days	3 mos. 18 days	48 mos. 29 days	21 mos. 24 days	8 mos. 25 days	30 mos. 19 days.
Total gain	47 lbs. 12 oz	79 lbs. 11 oz	2 lbs. 14 oz	82 lbs. 9 oz	32 lbs. 10 oz	5 lbs. 3 oz	37 lbs. 13 oz.
Average gain per capita per day.	0.635 oz	0.937 oz	0.426 oz	0.899 oz	0.798 oz	0.313 oz	0.658 oz.
Second period:	*15 babies.*	*29 babies.*		*29 babies.*	*13 babies.*		*13 babies.*
Time of feeding	17 mos. 1 day	25 mos. 23 days		25 mos. 23 days	10 mos. 13 days		10 mos. 13 days.
Total gain	19 lbs. 10 oz	40 lbs. 12 oz		40 lbs. 12 oz	17 lbs. 1 oz		17 lbs. 1 oz.
Average gain per capita per day.	0.614 oz	0.844 oz		0.844 oz	0.872 oz		0.872 oz.
Entire period:	*27 babies.*	*30 babies.*		*36 babies.*	*14 babies.*		*23 babies.*
Time of feeding	60 mos. 3 days	71 mos. 4 days		74 mos. 22 days	32 mos. 7 days		41 mos. 2 days.
Total gain	70 lbs. 15 oz	120 lbs. 7 oz		123 lbs. 5 oz	49 lbs. 11 oz		54 lbs. 14 oz.
Average gain per capita per day.	**0.629** oz	0.903 oz		**0.880** oz	0.822 oz		**0.713** oz.

The weight tables give individual and average ages and weights at the beginning of the study; individual and total time, in months and days, of feeding; individual gain or loss, in pounds and ounces, total gain, and average gain per baby per day. In the cases of Groups 2 and 3 separate tables are presented of such comparative weights as were obtained of the babies who were subsequently "Taken off." All comparative weights taken previous to October 22 were compiled and are here presented as "Time on," and "Gain" or "Loss" as of the "First period." Comparative times of feeding and comparative weights that were taken after October 22 and before November 13 are here presented as of the "Second period." Comparative times of feeding and comparative weights taken between the beginning of the study and November 13 are presented as of the "Entire period."

The averages of all groups, including age and weight at beginning, "Stayed on" and "Taken off," time on, total gain, and average gain per baby per day for all periods, are carried forward into a summary.

Satisfactory laboratory analyses and experiments with animals, the freedom from immediate dangers, and the increase in weight following the use of different foods used in infant feeding, are not sufficient criteria to warrant final conclusions relative to the comparative values of the different foods; nor, as has been said, are final conclusions warranted until the effects of use of different foods have been studied for a prolonged period. However, the opinions of trained and experienced workers—in this case the nurses of the Boston Baby Hygiene Association—who have had intimate contact with the units which go to make up a study of this kind, are of some value when considering the relative values of different foods.

Each nurse who had supervised one or more babies in Groups 2 or 3 (there were about 20 such nurses) was asked to express a conservative opinion on November 12 regarding the progress, with special reference to general development, activity, teething, and disposition, of such babies as she had supervised. In asking these opinions the point was emphasized, as it had been at all times during the study, that those who were cooperating in the study were not interested to determine superiority for any kind of food, but were only interested to secure facts as they exist. In order that these opinions might be reduced to a comparable basis, the nurses were asked to state how each baby had progressed on remade milk in comparison with the progress the same baby had made on its former diet (using the terms "Better," "No change," or "Not so well"), or with the progress similar babies are likely to accomplish on natural milk.

In this preliminary report the foregoing data—viz, laboratory analyses; removals from the powder, with special reference to the attitude thereto of the physicians and nurses of the Boston Baby

Hygiene Association; gain in weight per baby per day; and the judgment of the nurses as to the general development, activity, teething, and disposition of the babies in Groups 2 and 3—are used in drawing preliminary conclusions relative to the safety, usefulness, and comparative value of remade milk, of the brand employed, in infant feeding.

Conclusions From This Study.

Safety.—Such laboratory analyses as were made indicate that the dry milk powders and their remade products, used in this study, are safe for infant feeding.

Two babies died during the period of the study. Of these, one baby, a member of Group 2 (whole milk powder), died following an operation for a congenital defect. The other, a twin, and a member of Group 1, was badly nourished at the time she was placed on natural milk; she died of indigestion.

Only one other baby, a member of Group 2, developed serious illness. This illness resulted from misinformation furnished by the mother, who informed the conference physician that her baby was being fed on a milk mixture, when, as a matter of fact, she had been feeding him on a proprietary food which consists almost entirely of sugar. The conference physician prescribed whole milk powder in a strength corresponding with natural milk, as stated by the mother. A serious case of overfeeding resulted, but was followed by recovery.

These deaths and the serious illness are not considered to be significant so far as the foods used are concerned. Such other illnesses as occurred were slight and transitory.

In group 2, 49 babies in all were fed milk that had been reconstituted from whole milk powder. Nineteen babies were removed from this group. Two removals have already been accounted for. For various reasons, or for no material reason, 12 babies were removed within a few days, and 3 more after longer periods, by their mothers or by private physicians. Development of illness attributable to the milk powder was not a significant reason for these removals. Only 2 babies were removed from the powder by conference physicians or nurses. The conference physician removed 1 baby for the purpose of putting it on a fat-free formula. A conference nurse removed the other baby because other members of the family were using the milk powder.

The circumstances attending the removal of babies from the whole milk powder employed in this study furnish no indication that it is unsafe for infant feeding.

In Group 3, 28 babies in all were fed on remade milk which had been reconstructed from unsalted butter and skimmed milk powder. Difficulties experienced in making daily deliveries of this mixture,

account in larger measure for fewer babies being included in this group than in Group 2.

Fourteen babies were removed from Group 3. No baby in this group died, nor did any become seriously ill. The families of 2 moved and the babies were lost sight of; 5 were removed by their mothers for reasons that can not be considered adverse to the feeding mixture; conference physicians removed 7 for the purpose of putting them on other feeding mixtures.

The circumstances attending the removal of babies from the remade milk obtained by reconstructing unsalted butter and the skimmed milk powder employed in this study furnish no indication that the remade milk is unsafe for infant feeding; the circumstance that 50 per cent of the removals from reconstructed milk were approved by the conference physicians, as compared with 10 per cent in the case of milk that had been reconstituted from whole milk powder, justifies the conclusion that these forms of remade milk differ in their effects when fed to infants.

Usefulness.—In Group 1, 27 babies were fed on modifications of natural milk for a combined period of 60 months and 3 days; their combined gain in weight was 70 pounds and 15 ounces; the average gain per baby per day was 0.629 ounces.

In Group 2, 36 babies were fed on modifications of whole milk powder for a combined period of 74 months and 22 days; their combined gain in weight was 123 pounds and 5 ounces; the average gain per baby per day was 0.880 ounce.

In Group 3, 23 babies were fed on modifications of milk that had been reconstructed from unsalted butter and skimmed milk powder, for a combined period of 41 months and 2 days; their combined gain in weight was 54 pounds and 14 ounces; the average gain per baby per day was 0.713 ounces

While gain in weight alone is not sufficient evidence on which to base final conclusions relative to the adequacy of a food for infant feeding, and while it may prove that excess gain over that which has been considered normal may not be desirable, the foregoing figures seem to indicate that the whole milk powder and the skimmed milk powder and unsalted butter employed in this study are useful in infant feeding, and, further—and especially in the case of the whole milk powder, and in the case of babies who are undernourished and who digest natural milk badly—these remade milks may have points of distinct advantage in infant feeding. The figures also warrant the conclusion that reconstituted, reconstructed, and natural milks differ in their effects when fed to infants; and that reconstituted and reconstructed milks should be labeled and sold for what they are and that they should not be substituted and sold for natural milk in a manner to deceive the purchaser.

The figures further confirm the previous conclusion of the safety of this brand of remade milk in infant feeding.

Comparative Value.—The opinions expressed by the nurses with respect to the comparative value of reconstituted, reconstructed, and natural milk in infant feeding, and with special reference to the influence of these different milks on the babies' general development, activity, teething, and disposition, strengthen the conclusions already drawn—viz, that reconstituted and reconstructed milks, of the brand employed, are safe and useful for infant feeding, and that in certain respects, particularly in the case of reconstituted milk, and in the cases of babies who digest natural milk badly, they may have points of distinct advantage. The opinions of the nurses further strengthen the conclusion previously arrived at that reconstituted, reconstructed, and natural milks differ in their effects when fed to infants.

The facilities available for this study permitted the use of only one brand of dried milk powder. Therefore no conclusions are drawn relative to the safety, usefulness, advantages, or disadvantages of other brands of dried milk powder.

References.

1. Infantile Scurvy—A Study of its Pathogenesis. A. F. Hess. Amer. Jour. of Dis. of Children, *14*, 337, Nov. 1917.
2. The Effect of Age, Heat, and Reaction on Antiscorbutic Foods. A. F. Hess and Unger. J. Biol. Chem. *38*, 293, June 1919.
3. Factors Affecting the Antiscorbutic Value of Foods. A. F. Hess and Unger. Am. Jour. Dis. Child. *17*, 221, April 1919.
4. Antiscorbutic Value of Milk in Infant Feeding. Chick, Hume, and Skelton. Lancet *1*, 1, Jan. 1918.
5. Antiscorbutic Value of Cow's Milk—Fresh, Pasteurized, and Dried. Chick, Hume, and Skelton. Biochem. Jour. *12*, 131, 1918.
6. Effect of Heat on Antiscorbutic Properties of Some Milk Products. Hart, Steenbock, and Smith. J. Biol. Chem. *28*, 3, 5, June 1919.
7. Comparison Between the Antiscorbutic Properties of Fresh, Heated, and Dried Cow's Milk. Barnes and Hume. Lancet *2*, 323, Aug. 23, 1919.
8. The Nature of the Dietary Deficiencies of Rice. McCollum and Davis. Jour. Biol. Chem. *23*, 181, 1915.
9. The Cause of the Loss of the Nutritive Efficiency of Heated Milk. McCollum and Davis. Jour. Biol. Chem. *23*, 247, 1915.
10. The Relation of the Unidentified Dietary Factors, the Fat-Soluble A and the Water-Soluble B, of the Diet to the Growth-Promoting Properties of Milk. McCollum, Simmonds, and Fitz. J. Biol. Chem. *27*, 30, Oct. 1916.
11. Milk as a Source of Water-Soluble Vitamine. Osborne and Mendel. J. Biol. Chem. *34*, 537, June 1918.
12. Hopkins and Neville. Biochem. Jour. 7, 97, 1913.
13. Influence of Fresh and Autoclaved Milk on the Development of Neuritis in Animals. Gibson and Concepcion. Philippine J. Sc. *11*, 119, May 1916.